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OPERATIONAL PHASE OF FUMIGATION TESTS ON ORNAMENTAL PINES for Eradication of the European Pine Shoot Moth

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by

W. ILLIAM C. Meyer

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SNOQUALMIE NATIONAL FOREST
PACIFIC NORTHWEST REGION
U.S. DEPT. OF AGRICULTURE - FOREST SERVICE
MAY 1962

3400

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European Pine Shoot Moth Fumigation Project
Seattle 1960-1961

INTRODUCTION

The discovery of the European pine shoot moth (Rhyacionia buoliana SCHIFF.) in May 1959 at Bellevue, Washington signaled a new insect threat to the pine forests of Washington and Oregon. To date, all known infestations are confined to ornamental trees in nurseries and residential areas. Mugho pine is the tree most commonly infested, with Scotch pine next. These species are representative of extremes of crown form, mugho pine having a low bushy form, while Scotch pine has an upright form and open crown. Since these species represent the extreme conditions which may effect the penetration and circulation of the fumigant, they were used in most of the tests.

History

The insect was first identified in North America in 1914, but a survey a year later showed it was present in ten states. Now it is distributed along the east coast, through the central states, the lake states and southern and western Canada. In 1927, it was found near Victoria, B.C.; in 1938 at Vancouver, B.C.; and in spite of eradication programs, it has shown up again in Vancouver in 1941 and 1943 and in Victoria in 1956 and 1958.

Cooperative Survey

Upon discovery of the pine shoot moth in Washington, and at the request of the Northwest Forest Pest Action Council, a cooperative insect survey was made in the summer of 1960 to determine the extent of the infestation in the Puget Sound area and to search for the moth in communities where it was not known to exist, under a plan prepared by the Pacific Northwest Forest and Range Experiment Station. The survey showed that the shoot moth appeared to be sufficiently limited in distribution that, through eradication and quarantine, it might be prevented from becoming established in the native pine stands of Oregon and Washington.

Fumigation with Methyl Bromide

Methyl bromide, the fumigant which was used in this study, is a highly toxic gas, lethal to humans, animals and plants as well as insects. Because the gas is colorless, odorless and tasteless, it is especially dangerous as its presence cannot be detected except by the use of instruments.

COOPERATING AGENCIES

The project was undertaken at the request of the Northwest Forest Pest Action Council, which is composed of representatives of industry, state and federal agencies and the state forestry colleges. Recommendations as to the advisability and feasibility of attempting eradication will be made by the Northwest Forest Pest Action Council. The fumigation tests in Seattle and vicinity were conducted by the U.S. Forest Service with cooperating agencies sharing responsibilities as follows:

1. The Division of Timber Management, Region 6, U.S. Forest Service was responsible for general direction, financing, operational conduct of the project and reporting of operational phases.

   Benton Howard, Division of Timber Management, provided over-all direction and coordination. His responsibilities were to:

   a. Develop general plans for the project.
   b. Allocate funds and maintain over-all financial control.
   c. Establish values of pines as a basis for purchase of those killed during tests.
   d. Assess application of findings in relation to eradication and report on project as a whole.

   W. C. Meyer, was detailed to the Division of Timber Management from the Snoqualmie National Forest as project director. His duties were to:

   a. Prepare a work plan and operating budget for the fumigation operations covering organization procedures.
   b. Prepare a safety plan.
   c. Supervise, coordinate and conduct fumigation operations.
   d. Purchase equipment and supplies, certify accounts for payment and keep cost records.
   e. Devise sound operational procedures.
   f. Be fully alert to public reaction, foster public acceptance and good will.
   g. Secure agreements with owners of trees, establish instances of kill, and arrange purchase of dead trees at the established rates.
   h. Prepare a comprehensive report with recommendations regarding large scale fumigation procedures.

   The Snoqualmie National Forest was responsible for general business matters such as cost accounting, payrolls, vouchers, rentals, etc.

2. The Pacific Northwest Forest and Range Experiment Station was responsible for research planning, technical supervision and reporting of technical findings.

V. M. Carolin was technical director. His responsibilities were to:

a. Prepare study plans to determine whether methyl bromide fumigation will kill 100 percent of the shoot moth without seriously damaging pines.
b. Supervise technical aspects of treatment, analyze results as tests progress, adjust plans and procedures as needed.
c. Develop procedures for measuring insect mortality and and phytotoxicity and train crews in these procedures.
d. Analyze and report on the technical accomplishments of the project.

3. Plant Pest Control Division, Agricultural Research Service, provided special equipment on loan, assistance in research planning, and on-the-ground training in fumigation procedures.

R. M. Thompson was project consultant. His responsibilities were to:

a. Assist in preparing the study plan with particular emphasis on methodology.
b. Provide on-the-ground training.
c. Provide guidance in improving techniques of fumigant application.

4. Department of Natural Resources, State of Washington, was responsible for obtaining access to trees on private property for fumigation testing, and for such publicity or other action as necessary for public acceptance and support of the project.

D. R. Hopkins represented the Department of Natural Resources, State of Washington. His responsibilities were to:

a. Obtain releases from property owners for fumigation of pines in numbers and sizes required for the tests.

b. Take action necessary to insure public acceptance and support of project.

5. The owners of residential property on which the tests were made constituted a group whose cooperation was vital to the project. Infested trees needed for the tests were not available except on private residential property.

PROJECT PLANNING

The fumigation study, undertaken by the U. S. Forest Service at the request of the Northwest Forest Pest Action Council, was under the general direction of the Division of Timber Management, Region 6, with research direction by the Division of Forest Insect Research of the Pacific Northwest Forest and Range Experiment Station.

Project Research Plan

The research study plan for this project, written November 21, 1960, was revised by the Experiment Station on May 22, 1961 under the title "Evaluation of Fumigation with Methyl Bromide as a Measure of Eradicating the European Pine Shoot Moth," by V. M. Carolin and W. H. Klein of the Experiment Station. The research plan was the basis for the fumigation tests made under this project.

The plan lists these basic concepts:

(a) For successful eradication, 100 percent kill of the insect is necessary. Studies must establish both minimum and maximum application for different tree species.

(b) Studies should extend through all seasons of the year.

(c) A standardized and workable method of applying the gas is essential.

(d) Control recommendation must be "operationally realistic" as to duration of exposure, gas concentration, and temperature within the fumigation chamber.

The objectives stated were: To standardize fumigation treatment procedures, and to define treatment conditions for successful eradication.

The research plan also described equipment to be used in the tests, methods of standardizing treatment procedures, and methods of determining effects of various factors on the toxicity of the gas to both moth larvae and on the host trees.

Project Operation Plan

The operation plan for the project was written in June 1961 by W. C. Meyer, project director. It states objectives, lists the participating agencies, key individuals and their respective duties. It describes the organization and duties of the fumigation crew. It outlines the steps in the shoot moth fumigation process and lists the equipment used.

The objectives were:

(a) To determine whether fumigation of pines infested with European pine shoot moth with methyl bromide is biologically feasible as an eradication measure.

(b) To determine whether operational procedures can be devised to treat trees efficiently and safely and to secure estimates of costs.

The project was designed to carry out the tests described in the research plan. No previous fumigation of pines had taken place in this region, so experimental applications were needed to determine what dosages and exposure times were required under varying conditions of temperature and seasonal growth.

Project Safety Plan

The safety plan written in March 1961 by W. C. Meyer was reviewed and approved by the Regional Safety Officer and the Division of Timber Management.

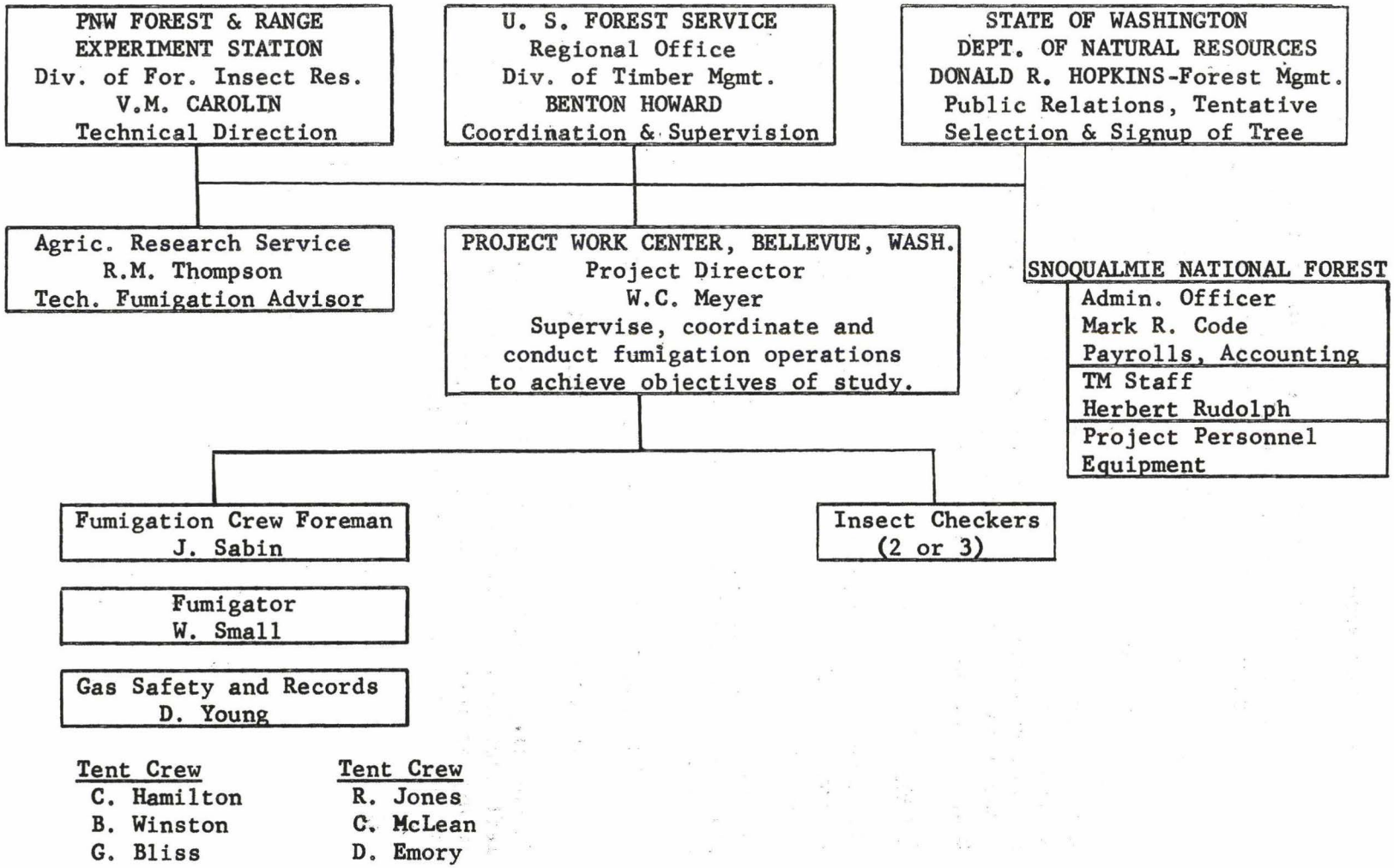
The fact that they were working daily with a lethal poison gas made all personnel realize the importance of the Forest Service safety policy:

"NO JOB IS SO IMPORTANT AND NO SERVICE IS SO URGENT THAT

WE CANNOT TAKE TIME TO DO OUR WORK SAFELY."

It was project policy that a chamber containing gas was never to be left unattended. Project safety objectives were: (1) no personal injury accidents; (2) no property damage or motor vehicle accidents; and (3) no exposure of project personnel or the public to gas fumes.

SEATTLE
EUROPEAN PINE SHOOT MOTH PROJECT
1960-61



PROJECT ACCOMPLISHMENTS

A total of 217 ornamental pine trees in residential areas in and near Seattle were fumigated with methyl bromide in four series of tests. The tests began in December 1960 and ended in November 1961, covering each season of the year.

In December 1961, 254 pines at a commercial nursery in Bothell were fumigated. Careful time studies were made for different phases of this fumigation work. A total of 1,386 man-days of work were spent on the fumigation project. This included the development of portable fumigating equipment, training personnel, developing and using new fumigation techniques and evaluating the results of fumigation, including larvae mortality and phytotoxicity of fumigated trees.

This study has added substantially to the scientific knowledge on the fumigation of pine trees in general, and on the control of the pine shoot moth in the Pacific Northwest. Costs from the beginning of the project through December 31, 1961 were $44,979.00. The tests have shown that methyl bromide fumigation of pine trees can be successfully performed, but that the costs of treating individual trees in residential areas are high. The excellent public cooperation experienced on this project indicates that public acceptance may be expected of well-organized control programs of similar impacts.

Safe methods and procedures for handling methyl bromide gas in residential areas have been developed with the invaluable assistance of Messrs. R.M. Thompson, Gilbert Harmon and Harold Shaefer of the Agricultural Research Service.

TRAINING

In order to train the field crew, which was composed of Snoqualmie National Forest personnel, the Agricultural Research Service sent three fumigation experts from California, headed by R.M. Thompson. These men worked with the fumigation crew during the three weeks of the December 1960 tests. On-the-job training was given in the construction of tents and frames, in the techniques of fumigation, and in the safety measures necessary in using methyl bromide. In addition to training and checking performance, Mr. Thompson worked with us in improving the equipment, and in improving the techniques of pine tree fumigation. Training in the research standards required in the study was given by V. M. Carolin.

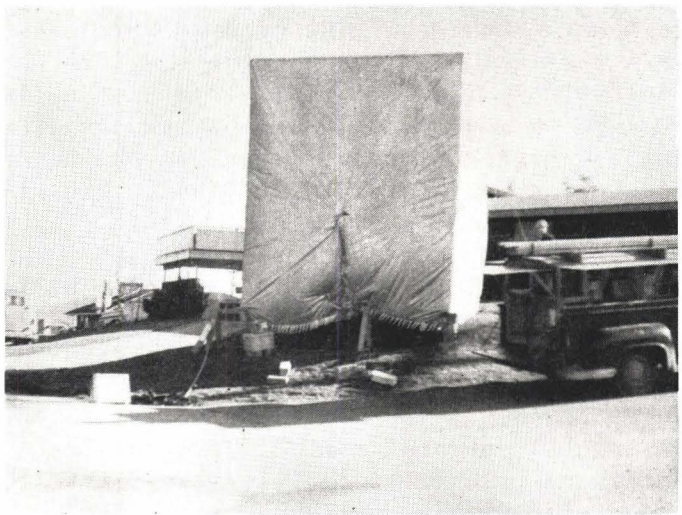
V. M. Carolin and W. H. Klein trained the crew and some of the State of Washington men in the recognition of pine shoot moth infestations and the degree of infestation required for fumigation tests.

EQUIPMENT AND ITS USE

Much of the equipment used on this project was adapted from standard fumigation equipment or from special equipment used by the A.R.S. on previous fumigation projects. Other equipment was built and developed on this project.

Fumigation Chambers

Fumigation chambers were made up as cubical tents from a plastic-coated nylon fabric, obtained from fumigation tarps provided by the A.R.S. These tents and ground cloths were made to fit wooden frames of four sizes; 3'x3'x3', 5'x5'x5', 10'x10'x10', and 12'x12'x14', which provided uniform chamber volumes into which measured amounts of gas were introduced. Dimensions and diagrams for frames are shown in the appendix.



Twelve cubic foot chamber positioned on side hill with aid of sawhorses.

The ground cloth was split to the center from one corner or from midpoint of one side. The slit was finished with a gussett and 6-inch skirt on each edge to provide for wrapping around the tree trunks and sealed by rolling together and clamping. The clamps used were #2 metal welders clamps. Wet sand was packed around the tree trunk to make a gas-tight seal.

Plasticized ground cloth positioned around tree.

A gas-tight seal was made between the tent and the ground cloth by rolling their edges together and clamping with spring clamps. Water was poured into the roll all around the tent to make a better seal. At first the gas introduction and sampling lines were passed diagonally through the rolled edges. Later the gas lines were put into the tents through grommet holes of a size to fit snugly over the plastic tubing. The use of the grommets proved superior.

Although the cubical chambers were used in all the tree fumigation tests for the sake of uniformity, two other shapes were designed and tried out. A cone-shaped chamber was made which proved unsatisfactory because, (1) it was hard to hold in shape to maintain its proper volume capacity, and (2) it did not fit the shape of the average pine tree. The second shape of chamber tried was cylindrical. A piece of 5-foot woven fence wire was bent into a circle 5.05 feet in diameter to make a frame.

A series of tests were conducted to compare the three types of chambers. The cylindrical tent was probably the lightest and easiest to handle, the cubical next, while the conical shape seemed unsuitable. These comparative chamber tests are described in a Pacific Northwest Forest and Range Experiment Station paper entitled "Suitability of Different Types of Chambers in Applying Methyl Bromide to Trees Infested with European Pine Shoot Moth," (Line Project No. FS-2-e4 - 2 PNW), June 16, 1961 by David Young and Wayne Small, members of the fumigation crew.

Gas Proof Spray Coat

After the tents and ground cloths were made, they were sprayed with aluminized paint which sealed the stitching and the material. This was obtained from Flexfirm Products, 2300 N. Chico Ave., El Monte, California, under their code Specification 02-249A, aluminum spray plastic, in spray consistency. This paint had to be thinned with acetone to work well in the spray guns. Acetone was also used to clean the gun. Tents were placed on a tent frame and then sprayed. Ground cloths were hung vertically. After spraying, a visual check for holes and thin coverage was made from inside the tent. The newly sprayed tents or ground cloths were dried in the open air for at least two days before being used. Pressure spray cans of clear plastic were used in the field to seal small leaks which developed during use.

The aluminum in the plastic paint reflected a substantial amount of solar radiation. On warm or hot days this helped to reduce the air temperature inside the fumigation chambers. Further reductions in chamber temperatures was gained by spraying water over the outside surfaces.

In October 1961, when it was difficult to get in-chamber temperatures high enough to meet the requirements needed for the September-October fumigation, a comparison was made to measure the difference between

the aluminum-coated exterior and the uncoated yellow exterior. Two 5-foot tents were set up in the open under a moderately heavy overcast sky. One tent was turned inside out with the unpainted yellow plastic surface exposed. The other was set in the usual manner with the aluminum side exposed. Temperature readings were as follows:

Outside Air Temperature in Shade	50°F.
Temperature Inside Aluminum Tent	52°F.
Temperature Inside Yellow Tent	70°F.

Thus the temperature in the yellow tent was 18° higher than in the aluminum tent. The use of dark colored tents for cold weather fumigation operations should be explored as a possible means of speeding up the fumigation process and reducing costs.

Chamber Frame Construction

The initial 5'x5'x5' chamber frame was constructed from 2"x2" stock for the corner uprights, with 1"x3" stock bolted to them making a cube that had to be assembled and disassembled at the site of operation. Another 5'x5'x5' chamber was devised, using all 1"x3" stock and hinging the corners in such a way that it could be folded together much the same as a dividing screen, and thereby assembled and disassembled very fast; this was a sturdier structure and just as portable as the original design.

The 10'x10'x10' chamber was constructed much the same as the 5' chamber with the exception of more bolts, and the use of guy wires running diagonally from the upper to lower corners. It was nearly impossible to erect with less than 4 men, and was quite time-consuming, requiring approximately 45 minutes.

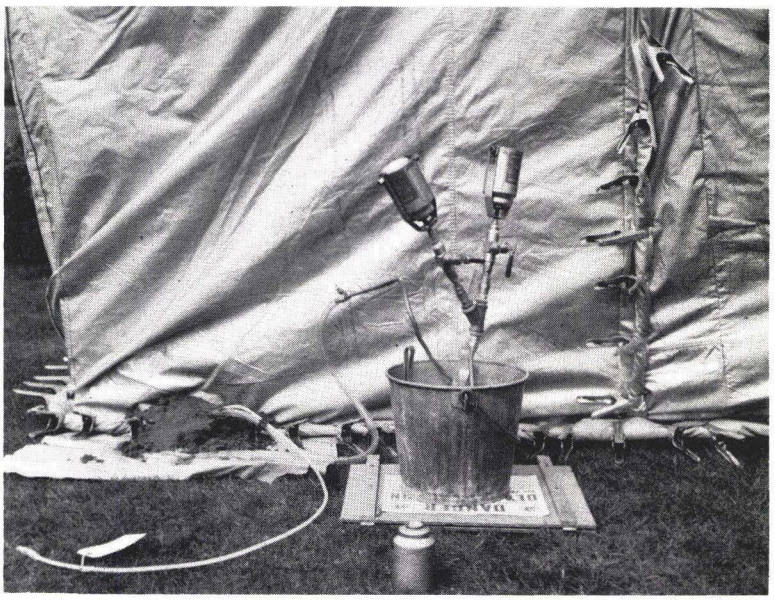
A 10' chamber was constructed with two sides preassembled using square metal tubing 6 feet high for the corner posts. These were bolted to cross members and braced diagonally with 1/8" angle iron. Wood corner posts, 2"x2", were then placed into the metal tubing making the frame adjustable from 6' to 10'. Four men could assemble the entire frame in 5 minutes.

Chamber Cover Construction

Tents and ground cloths were made from a plastic-coated nylon which was easy to rip in order to size and to sew. They were sewn with nylon thread on a heavy duty sewing machine. The diagrams in the appendix are not to scale, but show dimensions, shape and number of square feet of material required for the cubical chambers.

Introduction of Gas

The introduction of gas into the fumigating chamber involves two steps, (1) the measurement and release of gas into the introduction line, and (2) the heating of the gas as it goes through the line into the chamber. Methyl bromide vaporizes at 40.3°F., and is heavier than air. It is essential that the gas be heated as it enters the chamber to insure full vaporization and to promote thorough mixing with the air in the chamber.



Sealed chamber showing gas introduction line. Small tagged line attaches to fumiscope.

Methyl bromide was obtained in 1 pound and 1/2 pound pressure cans. When a small amount of gas was required, it was measured with a graduated plastic bottle connected to the gas introduction line with a shut-off valve on each side of the bottle.

The cans were opened by a special reinforced adaptation of the Crown can applicator, which cut into the top of the can when tightened, and allowed the gas to pass into the first section of the introduction line. For this purpose, an 18" length of transparent pressure-resistant 1/4" inside diameter I. D. "Tygon" plastic tubing was first used, which allowed the fumigator to see the liquid passing through the tube. This tubing sometimes blew out during use from the pressure surge when a can was opened. The plastic tubing was cooled by the liquid as it vaporized on leaving the can which apparently caused it to become hard and brittle. This caused it to break at the

point where the tubing was coupled to the can opener. This was a definite safety hazard, so the plastic tubing was replaced by flexible metal tubing with a "liquid eye" coupled to it. This allowed the operator flexibility of movement to empty the cans of methyl bromide, permitted visual observation of the liquid passing through the tube and made the operation less hazardous. The flexible metal tubing and liquid eye were obtained from a refrigerative supply company in Seattle.

Gas release mechanism and copper coil submerged in hot water.

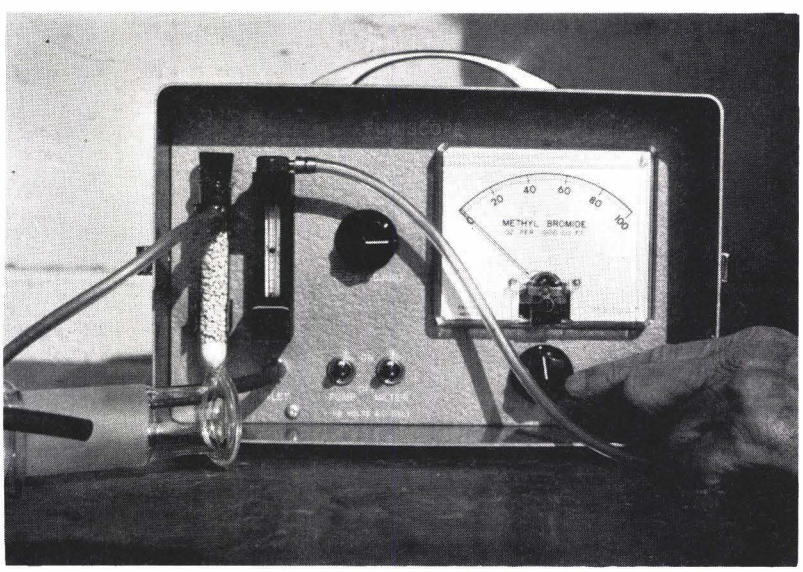
The gas was heated by conducting it from the applicator through a coil of copper tubing immersed in a 2½ gallon pail of hot water. The water was heated by a portable butane burner. The water temperature was kept above 140°F. while the gas was introduced. Each 1-pound can of gas introduced reduced the water temperature by about 10°F. From the copper coil the gas passed into the final section of the introduction line, a piece of plastic tubing long enough to reach inside the chamber to a point 5 to 8 inches below the top. Here the end of the tubing was directed at an adjoining corner of the chamber to avoid spraying the gas directly on the needles of the tree.

It was found that for all chamber sizes, except for the 3-foot cube, the 3/8-inch introduction lines are better than the 1/4-inch lines because the gas is inducted more quickly.

Special Opener

A special heavy duty gas can opener was made by the Neil A. MacLean Company to specifications worked out by Thompson and Small. This applicator holds the can securely while it is being opened, minimizing gas leaks. Can opening is one of the most hazardous operations performed in the fumigation procedure because of the possibility of the vapor-liquid squirting out if the can is out of position when opened. These openers cost $30.00 each.

An improved gas applicator was developed by R. M. Thompson which consisted of two openers each connected through a separated shut-off valve to a liquid eye on an upper leg of a pipe Y. The bottom of the Y was connected to a heating coil of 3/8-inch copper tubing which was immersed in a bucket of hot water. All connections were made with 3/8-inch I.D. brass pipe fittings, so the unit was rigid and safe from line breakage. This double applicator is faster, especially for larger dosages since one may be taken off and replaced while the other is discharging. This applicator is suited to discharging entire cans of gas when smaller amounts do not have to be measured. The MacLean Company's special can openers work well with this applicator.



Fumiscope records gas density inside sealed chamber.

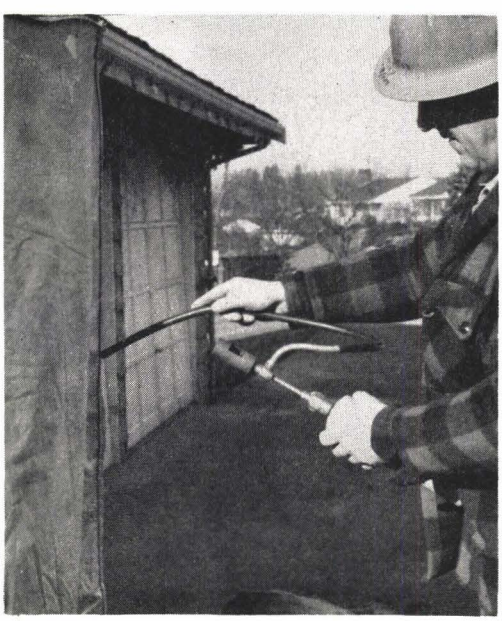
Measurement of Gas Concentration

The gas concentration during each fumigation exposure was measured 1/2 hour after gas induction and again during the last 1/2 hour of exposure. This gave a check on the amount of loss of gas during the test. Gas concentration inside the fumigation chambers was measured by a thermal-conductivity gas analyzer, commonly called a "fumiscope." A low-speed pump in the instrument draws a sample of gas through the sampling tube and the gas concentration in ounces per 1,000 cubic feet is measured.

A gas sampling line (1/4-inch plastic tubing), taped to the frame inside each chamber terminates 6 inches from the wall at mid-chamber height. In the gas circulation tests, two more sampling lines were used, one 6 inches below the top of the chamber and the other 6 inches from the bottom.

Halide Gas Detector

The Halide Gas Detector, which operates with a gas flame, is the easiest and most useful means of determining the presence or absence of harmful concentrations of methyl bromide gas. It consists of a torch which heats a copper cone, and an air tube through which the air to be tested is passed over the hot copper. In air containing methyl bromide, a green or blue flame will be seen in the torch, depending on the concentration. When methyl bromide is present at a concentration of 25 parts per million, the Halide Detector flame color appears as a faint fringe of green. When the concentration is 800 parts per million, the Halide Detector flame color is a strong blue-green. The Halide Detector should be a required piece of equipment for every fumigation job. If used properly, it will help to eliminate some of the hazards to the fumigator and detect excessive leaks in the fumigation chambers. Halide Detectors are available from refrigeration supply houses and some hardware stores.



The Halide Gas Detector used for detecting gas leaks.

Evacuation of Gas

The operation of evacuating the gas from the fumigation chamber is potentially the most hazardous step in the entire procedure. The objective is to vent the gas into the atmosphere without leaving a dangerous concentration either inside the chamber or in its vicinity. In the 5-foot chambers the venting is done with a heavy-duty vacuum cleaner motor connected to a 12-foot length of 2-inch diameter metal tubing directed upward. The motor is operated 10 to 15 minutes, depending on air circulation and wind at each location. Methyl bromide usually disperses rapidly into the air when there is a breeze, but under quiet air conditions, the gas sometimes tends to remain in concentrations that are dangerous. Under these conditions it is unsafe to be in the area without wearing a gas mask until the Halide Gas Detector indicates that the atmosphere is safe.

Gas evacuation from chamber through extended pipe.

For evacuating the 10-foot chambers, a Homelite gas engine equipped with a squirrel-cage fan having an 8-inch diameter intake and outlet was used. A piece of wire-reinforced flexible tubing 8 inches in diameter and 7 feet long was used for the suction line. A 9-foot vertical plastic sleeve was attached to the blower outlet, which sent the vented gas high into the air. The chamber vacuum was broken by venting the tent opposite the exhaust fan.

Since exposure duration and gas concentration are two of the three critical factors along with in-chamber temperature in the fumigation process, it is vital that complete plans be made to effect prompt evacuation on time. The individual responsible should have full information as to evacuation time for prescribed tests, and the necessary tables and graphs for cumulative vapor pressure tests. Good crew organization is essential here.

FUMIGATION PROCEDURES

General Project Description

Briefly, the procedure consisted of the fumigation with methyl bromide gas of representative species of pines in fumigation chambers of four standard sizes under measured gas dosages for given periods of exposure. To obtain the proper range of conditions for treatment, tests were planned for December and March in the dormant season of the host trees, and for May and September in the growing season.

The project was designed to carry out the research tests described in the Study Plan for the project, dated May 22, 1961, written by V. M. Carolin and W. H. Klein of the Pacific Northwest Forest and Range Experiment Station.

Preparatory to actual fumigation, the following steps were performed:

a. Special fumigation materials and equipment were supplied by the Agricultural Research Service in California. A work headquarters was established near Seattle in Bellevue, Washington.

b. Fumigation chamber frames and tents were made up on the job with assistance from A.R.S. personnel.

c. The State of Washington Department of Natural Resources located and procured initial permission for the trees to be treated.

d. Selection of individual trees for specific treatments was made by the technical director.

e. Execution of Forest Service reimbursement agreements with owners of trees that were to be treated was obtained.

Steps in Pine Shoot Moth Fumigation

From the beginning of the fumigation tests it was apparent that the steps in the process should be performed in a certain regular order. This saves time and avoids omission of essential steps. The order was as follows:

1. Check with the property owner to let owner know work is being started on the property. All owners have previously signed their permission on the Forest Service agreement form.

2. Put water on to heat, and blow moisture from tree if necessary. If the tree is wet, the moisture is blown off using the large blower to dry the tree. Since water is a barrier to the penetration of methyl bromide gas, moisture on the tree would be detrimental.

3. Remove dead limbs or other dead material from tree and from around tree trunk.

4. Measure tree as required. Place saw horses and blocks if they will be needed to support tent or to protect surrounding plants from injury.

5. Install ground sheet around tree trunk, roll flaps and seal with clamps and wet sand.

6. Assemble tent frame. Five-foot frames can be hauled on truck without taking down.

7. Put tent on frame, check for holes in tent.

8. Install introduction and sampling lines on frame.

9. Install fan if it is to be used, check fan operation.

10. Place tent and frame over tree. Tie rope guy lines from frame to tree to prevent wind from moving tent which can break the gas-tight seal.

11. Remove plugs from inside end of introduction and sampling lines.

12. Seal tent to ground sheet by rolling and clamping. Connect hose and sprinkle water over the rolled joint to improve the seal.

13. Install inside thermometer. Install outside thermometer.

14. Set up and turn on fumiscope to warm up, and zero the meter.

15. Get bucket of water for washing off liquid gas in case of accident. Put up "Poison Gas" signs.

16. Place gas applicator with copper coil in bucket of boiling water. Connect to introduction line.

17. Record time of beginning of gas introduction.

18. Measure and introduce gas into chamber.

19. Record time at completion of gas introduction.

20. Check for gas leaks in chamber with Halide Gas Detector.

21. Remove gas applicator from introduction line. Plug end of introduction line.

22. Take fumiscope and temperature readings at correct times. Arrange for tent to be guarded throughout exposure period.

23. At 15 minutes before the end of each exposure, check the vicinity to see that neighboring doors and windows are closed, that no persons are in evacuation area. Get evacuation equipment ready. Test gas engine on large blower.

24. At end of exposure time take final temperature readings, remove inside and outside thermometers.

25. At end of exposure put on gas mask, then put suction pipe of blower into tent, and prop open tent flap or skirt on the side of the tent opposite the motor. Finally, start motor, run as needed to evacuate all gas from the chamber.

26. Check evacuation area for gas concentrations with Halide Gas Detector.

27. When safe, take down equipment. Either carry it to the next tree or store it on the truck.

28. Clean up trash. Sweep walks and rake soil in beds where crew was working.

29. Thank owner and notify that fumigation is completed.

Crew Size and Organization

The size of the fumigating crew varied from 5 men in the first series of tests in December 1960 to 9 men in September 1961. In the first test series, the Experiment Station men and A.R.S. men who were working with the crew giving training, made the effective crew strength equal on the average to 6 men. A great deal of emphasis throughout the December tests was given to training.

In the second test series (February 1961), the field crew numbered 6 men. Under this plan the crew was organized to operate as a single unit and was equipped with one stake-side truck, 1 pickup truck with fumigation equipment box and 1 sedan to carry fumiscope.

In the third series of tests (May 1961), and the fourth series (September and October 1961), the crew organization was changed to form two 3-man tent crews. Each crew was provided with a stake-side truck which carried two 10-foot tents with telescoping metal frames and two 5-foot tents on frames ready to set up.

Organization - Foreman
Fumigator
Fumiscope & Records
Tent Crew - 3 men
Tent Crew - 3 men

DUTIES AND JOB DESCRIPTION OF FUMIGATION CREW

Crew Foreman

The crew foreman was responsible to the project director for the efficient functioning of the crew. His duties were as follows:

1. Manage the daily work of the fumigation crew; make work assignments.

2. Take direct responsibility for safety of crew and the public. See that each fumigation chamber was guarded constantly.

3. Take fumiscope readings and final temperature readings.

4. Thank property owner when through and check clean-up.

5. Keep time records on Form 26. Make vehicle equipment reports on the 25th of each month.

Fumigator

1. Inspect tent set-up and gas lines.

2. Insert thermometers and put out danger signs.

3. Introduce gas. Take first temperature readings. Leave record cards.

4. Be responsible for gas supply and empty cans.

5. Assist in gas evacuation and safety.

Fumiscope and Records Officer

1. Be responsible for data records; make extra copy.

2. Take fumiscope and temperature readings; guard tents.

3. Supervise gas evacuation. Use Halide Gas Detector to test for any gas in area.

Tent Crew (3-man crew)

1. Each crew leader will drive a truck and direct work of his crew.

2. Prepare tree and ground, put on ground sheet.

3. Set up tents. Install gas lines. Guy tent frame to tree.

4. Guard tents during fumigation as needed.

5. Help evacuate gas.

6. Take down and fold tents.

7. Maintain daily motor vehicle equipment reports.

Recommended Crew Organization

W. C. Meyer and W. Small worked out a proposed crew organization for large-scale fumigation operations such as would be encountered if 100 percent treatment of a large urban area were to be undertaken. A 12-man crew is proposed, composed of:

1 Foreman - to plan, supervise and inspect work.
1 Fumigator - to introduce gas into chambers.
4-man tent erection crew - to set up chambers. 8-4:30 shift.
2 guards - to guard chambers while charged.
4-man take-down crew - to evacuate and remove tents. 10-6:30 shift.
12 men

By having the erection crew confined to putting up tents without having to go back to evacuate and take down, it would be possible to eliminate time lost in backtracking and waiting. The erection crew could work an 8 to 4:30 shift and take-down crew work 10 to 6:30. Where trees are close, one man could guard 4 or 5 tents. Both tent crews could help with the guarding when needed.

On 10-foot trees it is estimated 10 would be done per day. Crew cost is 12 men at $2.00 per hour and equals $24.00 per hour or $192.00 per day. At 10 trees per day the cost would be $19.20 per tree, or 9.6 man-hours per tree.

On 5-foot trees it is estimated 14 could be done per day, which would give a treatment cost of $14.00 per tree, or 6.9 hours per tree. In the March tests the average was 10.3 man-hours per tree; in the May tests, 11.5 man-hours per tree. In both tests about half were 5-foot and half 10-foot trees.

SAFETY

The fact that the work on this project took place on urban residential property made public safety as well as crew safety a vital concern. Because the gas is colorless, odorless and tasteless except at relatively high concentrations, a man could be in a harmful concentration without knowing it. He might inhale enough to produce initial symptons of fatigue, headache, dizziness, nausea and mental confusion before he realizes there is gas present.

Thorough safety training at the beginning of a fumigation project, and careful review periodically are necessary to instill safe procedures. The European Pine Shoot Moth Project Safety Plan summarizes the practices and precautions which have been found essential to safely use methyl bromide gas. Our operational experience on the project has brought out some additional points that are worthy of mention:

1. The two most dangerous steps in the entire operation are (a) introducing the gas into the fumigation chambers, and (b) evacuating the gas at the end of the exposure period.

2. On an operational basis it would be advisable to develop alternate personnel to perform each of these two jobs, and change off, so that the same men will not be constantly exposed to these hazards.

3. The organic gas mask should be used by the man placing the gas evacuation equipment.

4. The gas mask canister should be worn on the side instead of on the chest where it is exposed to a maximum of gas fumes when opening the tent to put in evacuation equipment. On the chest position the opening of the canister may be obstructed by clothing when the wearer is stooping to open tent flap. The best position for the canister would be on the back if the hose were longer.

5. Oxygen inhalations should always follow any symptoms of exposure to the gas. A small oxygen cylinder should be carried in each vehicle used on the project.

6. On any extended fumigation project, personnel should be given a physical examination before they begin work for purposes of comparison should they suffer exposure to the gas.

A step by step procedure for evacuation of gas has been prepared because of the hazardous nature of this operation. It is included in the appendix.

APPENDIX

Details of Project Accomplishment

Roster of Personnel

Cost Data

Safe Evacuation Procedure

Chamber Tent Construction

Equipment Required in Methyl Bromide Fumigation

State Letter to Property Owners

Instructions for Signing up Property Owners

State List of Property Owners Form

State Fumigation Agreement Form

Forest Service Fumigation Agreement Form

Information for Cooperating Owners

Sample Data Card

DETAILS OF PROJECT ACCOMPLISHMENTS

Number of Trees Treated

December	1960	30	trees in Mercer Island and Bellevue
January	1961	10	trees in Mercer Island and Bellevue
March	1961	78	trees in Mercer Island and Bellevue
May	1961	41	trees in Mercer Island and Sand Point
Sept.-Nov.	1961	58	trees in Mercer Island and Sand Point
TOTAL		217	trees

Number of Properties Treated (All residences except School and Park)

December	1960	20 properties
Jan., March and May	1961	81 properties
Sept., Oct., and Nov.	1961	44 properties
TOTAL		145 properties

Number of Man-Days Worked on Fumigation -- 1386

11/20/60 - 12/31/60	128
1/1/61 - 6/30/61	664
7/1/61 - 12/31/61	594
TOTAL	1386

Funds Spent on Fumigation (Seattle Fumigation Project and Nursery Fumigation)

Nov. - Dec. 1960	$ 2,942
1/1/61 - 6/30/61	25,089
7/1/61 - 12/31/61	16,948
	$ 44,979

ROSTER OF PERSONNEL

Project Administration

Region 6 - U.S. Forest Service

Regional Director	Benton Howard
Safety Officer	Edward Blaser

Pacific N.W. Forest and Range Experiment Station

Technical Director	V. M. Carolin
Technical Assistant	W. H. Klein

Agricultural Research Service

Project Consultant	R. M. Thompson

Washington State Department of Natural Resources

State Representative	D. R. Hopkins

Control Unit Personnel

Project Director	W. C. Meyer
Crew Foremen	Gerald Sabin Wayne Small
Fumiscope and Records	David Young Ed Moulton
Tent Maker	Clarence Hamilton
Tent Crewmen	Vincent Burke Roy Jones Donald Emery Claude McLean Bruce Winston Jack Holt Merritt Nash
Insect Checkers	Virginia Emery Carol Williams Sue Ann Poth Gordon Christopher

COST DATA

Methyl Bromide in 1/2 pound cans costs $0.85 per pound, Methyl Bromide in 1 pound cans costs $0.75 per pound, both when purchased in case lots.

The aluminum plastic paint used to coat the fumigation chambers costs $5.50 per gallon. A total of 145 gallons was used at a cost of $794.

Materials for the improved telescoping metal 10-foot tent frame cost approximately $65.00 for each frame.

Man-hours per tree were figured for the March and May tests only, because of weather fluctuations during the September-October tests.

	MARCH	MAY
Men on Crew	6	6.3
Days Fumigating	17	10
Man-Days	101	63
Man-Hours	807	495
Number Trees Treated	78	43
Trees per Day	4.6	4.3
Man-Hours per Tree	10.3	11.5

About one-half were five foot trees and one-half were ten foot trees.

Ornamental Pine Tree Payment Schedule

Maximum amounts approved for payment by species and sizes for pines killed in fumigation tests were:

Size (Height in feet)	Species of Pine	
	Mugho	All Other
0-3	$ 7.50	$ 6.00
3.1-5	12.00	8.00
5.1-10	20.00	12.00
10.1-15	30.00	20.00
15.1 and higher	45.00	30.00

STEPS IN SAFE EVACUATION PROCEDURE

1. Fifteen minutes before chamber is ready for evacuation, place should be chosen for the blower suction pipe. Generally it depends on the position of the chamber, direction of the wind and position of nearby buildings. Ventilation bucket goes opposite the suction pipe. Place blower and pipes beside chamber.

2. Check neighboring houses for open windows, doors, etc. If any children or pets are around, ask adults to take them indoors, or keep them away and windward.

3. Check blower motor to ascertain if it is in working conditions; check gasoline tank. Take final temperature readings.

4. Take off clamps where suction pipe and vent are to go. This can be done without mask.

5. Put on the mask, placing filter on the left side of the body. It will not interfere with movements as bending, crouching, etc. Also intake of the filter will not be closed in this position. Check face mask to see that it fits tightly and that all straps are properly adjusted and in correct position.

6. Open previously prepared place and insert suction tube.

7. Open and insert ventilation bucket.

8. Start blower motor and be sure that it is running properly.

9. Move windward from the chamber and remove mask.

10. Ignite Halide Gas Detector torch to be ready for checking.

11. Watch for pedestrians and keep them away from downwind direction of evacuation.

12. After blower has run sufficiently, put on mask and start checking concentration of gas around chamber and inside with Halide Gas Detector.

13. After ten minutes, when concentration is found to be low in the vent and around suction tube, take off more clamps and make bigger openings opposite the suction tube.

14. When Halide Gas Detector shows safe, shut off motor, take off all clamps and fold up sides of chamber.

15. When final check with Halide Gas Detector inside chamber shows no concentration, it is ready to be taken down. Write minutes used on gas mask canister, usually as a cumulative figure. Discard canister at 100 minutes of use.

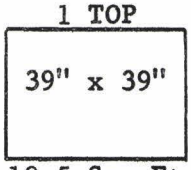
In case of persistent concentration of gas in pockets and folds, mostly due to lack of wind, put suction pipe on the outlet of the blower and insert it once again into the chamber, this time to blow the gas out.

Remember that the effective capacity of the organic gas mask is limited to low to moderate gas concentrations; do not depend on it to protect you in high or full dosage concentration.

CHAMBER TENT CONSTRUCTION

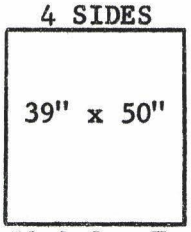
3' x 3' x 3' Chamber — 106.2 Sq. Ft. of Material

1 TOP



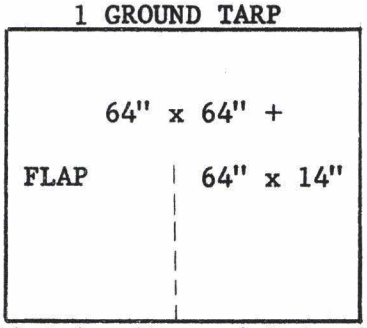
10.5 Sq. Ft.

4 SIDES

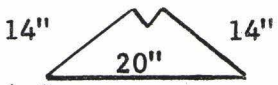


58.2 Sq. Ft.

1 GROUND TARP



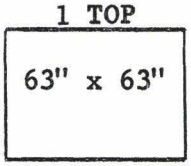
28.5 Sq. Ft. + 6.2 Sq. Ft.



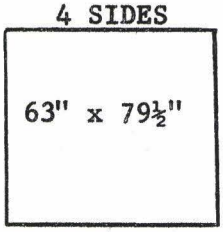
4 Gussets
2.8 Sq. Ft.

5' x 5' x 5' Chamber — 248.4 Sq. Ft. of Material

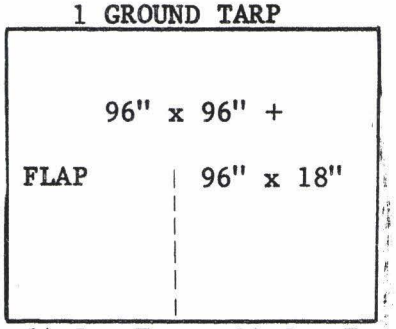
1 TOP



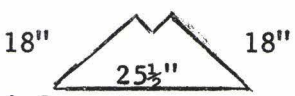
4 SIDES



1 GROUND TARP

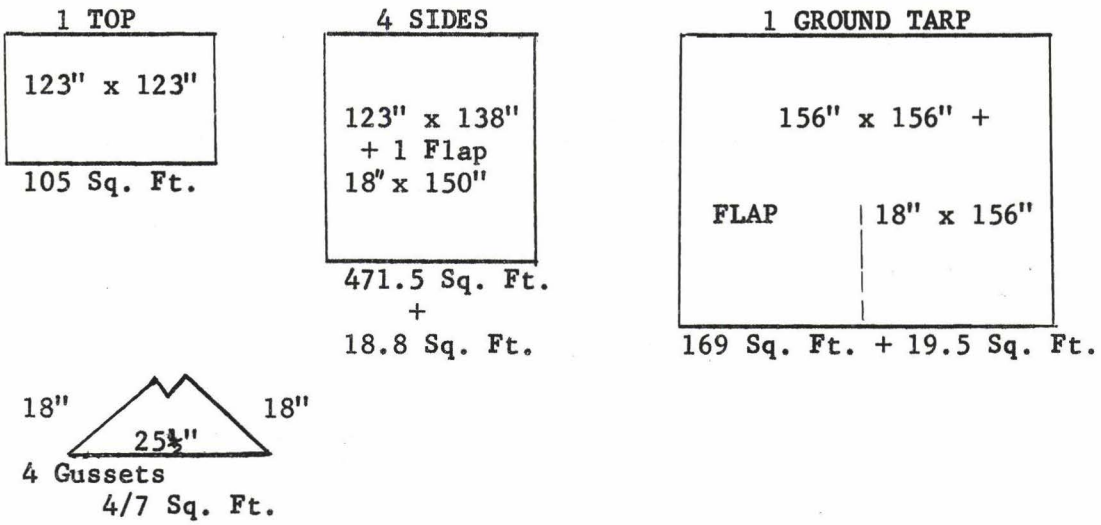


64 Sq. Ft. + 12 Sq. Ft.



4 Gussets
4.7 Sq. Ft.

10' x 10' x 10' Chamber — 788.5 Sq. Ft. of Material



MATERIAL REQUIRED

3' x 3' x 3' Chamber	106.2 Sq. Ft.
5' x 5' x 5' Chamber	248.5 Sq. Ft.
10' x 10' x 10' Chamber	788.5 Sq. Ft.

MAN HOURS TO MAKE

3' x 3' x 3' Chamber	7 Man Hrs. to Assemble	1 Man Hr. to Paint
5' x 5' x 5' Chamber	8.5 Man Hrs. to Assemble	1½ Man Hr. to Paint
10' x 10' x 10'	12 Man Hrs. to Assemble	3-4 Man Hrs. to Paint

EQUIPMENT USED IN METHYL BROMIDE FUMIGATION

EUROPEAN PINE SHOOT MOTH PROJECT

1. Tents (Fumigation Chambers)
2. Tent Floors
3. Clamps
4. Sand Buckets
5. Lath Strips
6. Tent Frames and Guy Wires
7. Introduction Line
8. Sampling Lines
9. Fans (if needed)
10. Extension Cords
11. Inside Thermometer
12. Outside Thermometer
13. Goggles to protect eyes
14. Masking Tape
15. Polyethylene Tape
16. Blocks (for tent frame) and small adjustable saw horses
17. Scrap sheets to catch sand
18. Fumiscope
19. Inverter
20. Battery
21. Dry-Rite (Desiccant)
22. Bottle for used Dry-Rite
23. Methyl Bromide
24. Water Heater & Butane Tank Gas
25. Gas Applicators with heating coil
26. 2 Buckets
27. Garden Hose and Nozzle
28. First Aid Kit
29. Gas Mask and Oxygen Cylinder
30. Halide Torch
31. Plastic Spray
32. Wrenches
33. Line Plugs (for introduction and sampling lines)
34. Data Sheets and Clip Board
35. Poison Gas Signs
36. Exhaust Fan (small) & Discharge Pipe
37. Exhaust Fan (large) and flex tubing and ventilation bucket
38. Extra nuts, bolts, washers and wing nuts
39. Plastic-coated gloves
40. Push Broom and cultivator tool
41. Shovel
42. Flashlight (in winter)
43. Rope, 1/4" - 50 feet
44. Extra plastic tubing for repairing induction and sampling lines
45. Garbage Can

(Copy)

STATE OF WASHINGTON

Department of

NATURAL RESOURCES

Box 110
Olympia, Washington

November 22, 1960

FM
COOPERATION
Northwest Pest Action Council
European Pine Shoot Moth

Open letter to property owners:

The European pine shoot moth has become established on ornamental pines in Seattle and vicinity. Great economic loss to the people of Washington and the West generally would occur should it spread to commercial pine forests. Local, state, and federal agencies, working with many individuals, are attempting to prevent this catastrophe.

A first essential step is to develop and test a reliable means of eradicating the insect. This means getting rid of absolutely all the shoot moths now present, a very difficult undertaking. Spraying will not accomplish it. Fumigation is the only method, other than destruction of infested trees, that promises success, but this treatment must be thoroughly tested to determine its reliability.

Tests must be conducted on infested trees growing in residential areas, for that's where the moth now is. The cooperation of many home owners is needed to assure success of this research project. Your help in granting access to infested pine trees on your property would be a public service much appreciated by all owners and managers of state, federal, and private forest lands.

Very truly yours,

BERT L. COLE, Commissioner

BLC/DRH/ahe

SEATTLE EUROPEAN PINE SHOOT MOTH PROJECT
Washington State Department of Natural Resources
and U.S. Forest Service

Instructions for signing up property owners for experimental fumigation of pine trees.

In all phases of this project our public relations are of greatest importance in order to secure and maintain public acceptance of the program. This is important in the search for suitable trees for treatment, and in securing permission for treatment from the property owner. Before entering a residential property to look at trees, explain to the owner briefly that this is an experimental program aimed at finding a practical method of controlling the disease, and that you wish to examine their pines to see if they are suitable for treatment.

Ask if the property or the trees have been sprayed within the past 6 months. If trees show serious spray damage we cannot treat them in this study because the spray effects might be confused with the results of fumigation.

Number and Sizes of Trees Needed from Experiment Station List

Size	Mugho	Scotch	Other Species	Total
2'-3'	6	4		10
3'-5'	112	130	30	272
5'-10'	102	130	30	262
10'-15'	6	4		10
TOTAL	226	268	60	554

With the fall tests completed, we will need 600 trees signed up in the proportions listed above in order to allow some selection as to suitability for treatment and location.

The suggested steps in the tree selection and sign up process are as follows:

1. Identify yourself and your organization.

2. Explain to property owner the agencies involved, the purpose and experimental nature of the project. Explain some trees may die from the treatment and that we can reimburse them for loss.

3. Ask if trees have been sprayed in past 6 months.

4. If infected and without serious spray damage, ask if they will give us their permission and sign the list.

5. Explain requirements of study (no spraying, pruning or dusting of trees) and leave copy of information for cooperators sheet and copy of moth survey folder.

6. Examine trees for signs of moderate or heavy infection, must have 25 to 30 infected buds or more, measure height class.

7. Check each tree for accessibility and feasibility of applying the size of cubical frame required. Rule out trees situated on steep banks, among big rocks or other trees where we can't get the ground cloth and tent properly in place.

8. Identify tree species.

9. Record trees by species and size class. Use separate line for each species or size class required.

10. Try to select trees where you can get 5 or 6 within a block.

1/23/61 W.C. MEYER

STATE OF WASHINGTON
DEPARTMENT OF NATURAL RESOURCES
BERT L. COLE - COMMISSIONER

LIST OF PROPERTY OWNERS WILLING TO PERMIT EXPERIMENTAL FUMIGATION OF THEIR PINE TREES FOR CONTROL OF THE EUROPEAN PINE SHOOT MOTH

Address	Locality	No. of Pines	Range in height	Principal species	Signature of Property Owner	Comments

* Abbreviate as follows: M - Mugho pine, L - Lodgepole pine, S-Scotch pine, A - Austrian pine, etc.

STATE OF WASHINGTON
DEPARTMENT OF NATURAL RESOUCES

AGREEMENT

THIS IS TO CERTIFY, That we, the undersigned, being the owners and/or mortgagee of that certain real property situated in _____ County, State of Washington, and more particularly described as follows:

Do hereby grant to the State of Washington, Department of Natural Resources, and to its officers, employees and agents, and/or to the United States Forest Service, and its officers, employees or agents permission to enter upon the foregoing described real property until such time as this agreement may be withdrawn by written notice given to the State of Washington, Department of Natural Resources, Box 110, Olympia, Washington.

The undersigned or legal owner hereby grants permission to the Department of Natural Resources, and the U.S. Forest Service, to enter upon the foregoing real property for the purpose of conducting experimental methyl bromide fumigation on pine trees on the foregoing property, to eradicate the European pine shoot moth. In consideration of the benefits to be derived by the owner and the public from this experimentation, the owner agrees not to hold the Department of Natural Resources, it officers, employees, agents and/or the U.S. Forest Service, its officers, employees, or agents liable for any damage to his trees resulting from these experiments; or any damage to the rest of his property resulting from the experiments which damage could not be reasonably avoided.

Dated at _____, Washington, this the _____day of _____, 19 _____.

_____

_____

_____

_____

_____

_____
Owners, etc., of said property.

_____
For the State of Washington
Department of Natural Resources

U. S. FOREST SERVICE
R-6
AGREEMENT

THIS IS TO CERTIFY, That we, the undersigned, being the owners and/or mortgagee of that certain real property situated in _____ County, State of Washington, and more particularly described as follows:

do hereby grant to the U. S. Forest Service, to its officers, employees and agents permission to enter upon the foregoing described real property until _____ ___, 1961 or such time as this agreement may be withdrawn by written notice given to the U. S. Forest Service. The grant of this right is without charge to the Forest Service.

The undersigned or legal owner hereby grants permission to the U. S. Forest Service, to enter upon the foregoing real property for the purpose of conducting experimental methyl bromide fumigation on pine trees on the foregoing property, to eradicate the European pine shoot moth. One of the purposes of this experiment is to determine the level of treatment at which phytotoxicity occurs. It is, therefore, agreed that the Forest Service will reimburse the owner, in the amount not exceeding that specified below for any tree which does not survive treatment. If tree survives treatment, no reimbursement will be made. Determination of whether or not a tree survives will be made as of _____ ___, 1961 by the U.S. Forest Service. Loss of tree after that date is not reimbursable by the U.S. Forest Service.

Tree Number	Species	Size	Amount

Dated at _____, Washington, this the_____ day of _____, 19 ___.

U. S. Forest Service

By _____

Title _____

_____

_____

_____
Owners, etc., of said property

EUROPEAN PINE SHOOT MOTH STUDY
UNITED STATES FOREST SERVICE, DEPARTMENT OF AGRICULTURE
905-Second Avenue
Seattle, Wash.

In reply
refer to:

3400

Information for Cooperating Property Owners

This study is being conducted by the U. S. Forest Service on a scientific basis to work out a method for the control of the Pine Shoot Moth. From the time the property owner gives consent for treatment until the field study is completed 5 months later, we are dependent on the owner to help maintain the trees in proper condition for the study. Your help is vital to success.

The conditions necessary are as follows:

1. The trees must not be sprayed or dusted with insecticide.

2. The tree should not be trimmed, the new shoots and buds should not be disturbed or cut. The Forest Experiment Station men will clip bud samples.

3. Trees should not be fertilized or given more than mormal watering.

It is pointed out that some trees will be given heavy dosages of fumigant which may kill a few trees, but reimbursement will be made by the Forest Service for such trees.

Thank you very much for your interest and active cooperation, which is an essential part of the study.

Very truly yours,

W. C. Meyer
Project Director

Phone
SH 6-6818

EUROPEAN PINE SHOOT MOTH

TREE NUMBER _____ LOCATION _____

SPECIES OF PINE _____ DATE OF TEST _____

GAS CONCENTRATION _____

CONDITIONS RECORDED

Time Minutes	- Temperature - In Chamber	Outside	Mid-Chamber Gas Pressure
0			- - - -
30			- - - -
60			- - - -
90			- - - -
120			- - - -
150			- - - -
180			- - - -